REMARKS

Claims 50, 67-69, 71-73, 80 and 81 stand rejected under 35 U.S.C. 103(a) as being unpatentable over Emmett, Jr. (US 5,007,620) in view of McWhirter (US 6,299,776), Eppstein (US 4,680,267) and Whellock (GB 2,225,256). It is an important element of the method of the present invention that the slurry in a bioleach reactor is subjected to a temperature in excess of 45 °C. This is due to the recognition that temperatures higher than the 46 °C temperature limit, identified by Emmett (see column 21, lines 10-20), greatly increase the rate of bioleaching in the reactor. This may be due in part to kinetic considerations. However, at temperatures exceeding 45 °C, a problem arises that the solubility of oxygen decreases significantly. This impacts on the availability of dissolved oxygen in the slurry and therefore is a principal factor limiting bio leaching at these temperatures. The Applicants have recognized the problem as one that needs to be solved in order to take advantage of the higher bio-leaching rates at these temperatures. Whellock and Emmett (see column 2, lines 31-35) recognize a general difficulty in transferring a gas from the gas phase into the liquid (slurry) phase. However, Whellock and Emmett fail to recognize that this difficulty is significantly greater at temperatures above 45 °C. Whellock, like the Applicant, recognizes that the rate at which a gas (oxygen) moved from the gas phase to the liquid phase is dependent on an oxygen driving force and a mass transfer coefficient. A relationship between these two factors may be represented as follows:

$$R = M (C^* - C_L)$$

where: R = mass transfer rate ($kg/m^3/s$);

M = mass transfer coefficient (s^{-1});

C^* = oxygen concentration in the gas phase (kg/m^3); and

C_L= oxygen concentration in the liquid phase (kg/m^3).

In increasing the mass transfer rate (R), in an attempt to solve the problem, the oxygen driving force (($C^* - C_L$)) must increase. This may be dome by increasing the oxygen concentration in

the gas phase (C^*) and/or decreasing the oxygen concentration in the liquid phase (C_L), with or without a concurrent increase in the mass transfer coefficient (M). An increase in M has been brought about by:

1. gasifying a slurry to foam (Whellock);
2. producing a droplet stream from the slurry using a surface aerator (McWhirter);
3. using a plurality of rotating diffusers to introduce a gas into the slurry (Emmett).

However, there is a significant cost attached to the use of these methods. The cost associated with the mechanics of the methods and the relatively high energy demands in operating them. Recognizing this, the Applicants focused on the oxygen driving force in solving the problem. In order to increase the oxygen driving force, a step of increasing C^*, possibly with the introduction of oxygen enriched air or pure oxygen, would be required. Keeping C_L as low as possible may complement this step. Initially taking this step may appear to be obvious, however, the step is fraught with potential problems, problems recognized by the Applicant. Arbitrarily enriching air with oxygen, and introducing this to the reactor, may initially achieve the desired result in increasing R. However, this may result in oxygen being provided to the slurry in excess of the microorganisms' requirement. Consequentially, C_L will increase with a concomitant decrease in the oxygen driving force and an eventual slow down in R. Furthermore, C_L will reach levels high enough that the oxygen will start to have an inhibitory effect on the microorganisms themselves. An additional problem is that enriching air with oxygen or using substantially pure oxygen is an expensive undertaking. The cost associated with this step can only be financially justified if most of the oxygen, supplied as oxygen enriched air or substantially pure oxygen, is utilized by the microorganisms in the slurry. Value parameters for C^* and C_L need to be identified that result in a balance being reached between the mass transfer rate of oxygen into the slurry and the uptake rate of oxygen by microorganisms in the slurry. However, these identified parameters cannot limit the availability of dissolved oxygen in the slurry, thus reducing the uptake rate. The Applicants unexpectedly discovered that by supplying a feed gas, containing in

excess of 85% oxygen by volume (i.e. a high C* value), to slurry at a temperature in excess of 45 °C, whilst controlling C_L within the range 0.2×10^{-3} kg/m^3 to 10×10^{-3} kg/m^3, a balance was achieved between the mass transfer rate and the uptake rate. The results of an experiment carried out by the Applicants (see Table 2 of the Specification) support this contention. The results show, when using the method of the Applicant's invention, that 93% of the oxygen supplied to the reactor was utilized. With such a high level of oxygen utilization, oxygen levels cannot build up in the slurry thereby increasing C_L and becoming inhibitory. The uptake rate was not limited by dissolved oxygen availability as there still remained a small excess of oxygen supplied to the slurry over oxygen used by the microorganism (i.e. 7% of the oxygen supplied), and C_L levels remained relatively constant (i.e. 2.5 mg/l). It is the unexpected discovery of oxygen concentrations in excess of 85% oxygen by volume C* and oxygen concentrations in the range 0.2×10^{-3} kg/m^3 to 10×10^{-3} kg/m^3 for CL and using these value parameters in a method of bio-leaching at temperatures that exceed 45 °C, that is this invention. As the method of Emmett is limited to temperatures below 45 °C, and as there is a technically motivated reason for conducting the method of the Applicants above 45 °C, it is not seen that Emmett can be relied upon to form the foundation of an obviousness type argument against the Applicant's application. As stated in our previous response, the Emmett reference states that certain bacteria are extinguished or their activity severely limited at temperatures above approximately 46 °C (see column 21, lines15-17). This statement merely provides information relating to a known problem associated with certain bacteria and the reason why a lower temperature is used during bioleaching. The Emmett reference clearly does not teach or suggest operating the bioleaching process at this higher temperature. In fact, the Emmett reference specifically discloses a slurry temperature within the range of 30-36 °C (see column 11, lines 63-65). Therefore, one of ordinary skill in the art would not be motivated to use the disclosure in Emmett for bioreactors having a slurry temperature in excess of 45°C. Furthermore, Emmett's description of the use of oxygen concentrations ranging from 1.0×10^{-3} kg/m^3 to 4×10^{-3} kg/m^3 makes no mention of the significance of this range and the necessity to maintain this range to optimize the bio-leaching

rate. This range is disclosed out of context to the Applicants' method and the range of 0.2×10^{-3} kg/m^3 to 10×10^{-3} kg/m^3. McWhirter acknowledges that the availability of dissolved oxygen in the slurry determines the rate of bio-leaching, and teaches a method of improving this availability. McWhirter's method teaches increasing the mass transfer coefficient (M) by producing a droplet stream from the slurry using a surface aerator and by the indiscriminate addition of a gas containing between 21% and 99% oxygen. No mention is made of the unique difficulties associated with making dissolved oxygen available to the microorganisms in the slurry above 45 °C without the need to increase M. Therefore, one of ordinary skill in the art would not be motivated to use the disclosure in McWhirter in a bioleaching process having a slurry temperature above 45 °C while controlling the oxygen concentration in the slurry to the level claimed. Whellock mentions that his method of improving the mass transfer of oxygen by gasifying the slurry may be used at temperatures of 70 °C with the use of a gas stream of oxygen or air. However, Whellock does not teach that the mass transfer of oxygen to a slurry may be increased by merely obtaining and maintaining a suitable oxygen driving force; this without the need to gasify the slurry. Whellock found (see column 1, lines 34-40) that although a higher oxygen driving force should logically be necessary to improve the mass transfer, his results actually showed a relatively small improvement attributable to a higher oxygen driving force. Much of the improvement in the mass transfer, according to Whellock, is attributable to subjecting the biomass to turbulence and shear whilst gasifying the slurry (i.e. increasing M. This, it is submitted, is the crux of Whellock's invention. The Examiner recognizes the shortcoming in Emmett (bottom of page 2 of the Office Action) but relies on McWhirter and Eppstein to provide the missing subject matter. However, Applicants submit that the Examiner has not provided a motivation for combining the cited references. Even though the prior art reference may be in the same "field of the applicant's endeavor…the test of whether it would have been obvious to select specific teachings and combine them as did the applicant must still be met by identification of some suggestion, teaching or motivation in the prior art". <u>In re Dance</u>, 160 F.3d 1339, 48 USPQ2d 1635 (Fed. Cir. 1998). Applicant submits that the Examiner

is merely selecting elements from a variety of prior art references directed to bioreactors to obtain the Applicants' claimed invention. Specifically, The Examiner is not permitted to merely "pick and choose among individual elements of assorted prior art references to recreate the claimed invention". SmithKline Diagnostics, Inc. v. Helena Laboratories Corp. 859 F.2d 878, 8 USPQ2d 1468 (Fed. Cir. 1988). The Examiner must show a teaching or suggestion in the prior art to support the combination. Furthermore, the extracts from these citations do not in combination disclose nor suggest all of the elements of claim 50 i.e subjecting the slurry in a reactor to a bio-leach process at temperatures in excess of 45 °C (1), supplying a feed gas which contains in excess of 85% oxygen by volume to the slurry (2) and controlling the dissolved oxygen concentration in the slurry in the range 0.2×10^{-3} kg/m^3 to 10×10^{-3} kg/m^3 (3). The Examiner relies on Whellock (page 3 of the Office Action) in support of an obviousness argument. Again, the Examiner has elected to "pick and choose" elements from a reference in the "field of the applicant's endeavor" in order to meet all the limitations claimed by the Applicants without providing a motivation in the reference for combining this reference with the other three references cited . Whellock's significance of adding the gasifying step "for the purpose of feeding pure oxygen at low concentrations to improve oxygen uptake rates" is unclear in view of the fact that a gasifying step, or a "violent agitation" step for that matter, is unnecessary in the Applicant's invention. Notwithstanding the preceding comment, Whellock's disclosure of elements 1 and 2 are completely out of context to that of the invention as claimed. Whellock merely mentions that oxygen may be employed instead of air (column 4, line 50), enhancing his "violent agitation" method, and that his invention may be operated at temperatures in the region of 65 °C to 70 °C, using atmospheric air (column 6, line 49). Element 3 is nowhere mentioned in Whellock. Whilst it is generally obvious to optimize reaction conditions to maximize reaction rates (top of page 4 of the Office Action), the optimizing conditions, recognized as optimizing in combination by the Applicants and including elements 1, 2 and 3, are not disclosed in this manner in any of the cited prior art. The shortcoming of Emmett's disclosure of the range of 0.2×10^{-3} kg/m^3 to 10×10^{-3} kg/m^3 has already been mentioned. The

Applicants therefore submit that the Examiner's obviousness rejection to claim 50 is overcome. Furthermore, the rejections of claims 67, 68, 69, 71, 72 and 73 are overcome due to their dependency on claim 50. Claim 80 stands rejected (top of page 5 of the Office Action), once again in light of Emmett, McWhirter and Eppstein. Once again extracts from these citations fail to disclose or suggest, in combination, all of the elements of claim 80. In particular, none of the references discloses controlling the supply of oxygen to the slurry to achieve a dissolved oxygen concentration in the slurry in the range 0.2 x 10-3 kg/m3 to 10 x 10-3 kg/m3. With respect, identifying a specific range within which to control the oxygen concentration is not the same as the indefinite step of "controlling the dissolved oxygen level in a bioreactor to a desired high amount to facilitate the reaction". As explained in the introduction of this section, it is not obvious to have fed pure oxygen gas to a reactor in order to improve the reaction rate of a bio-leaching process. The Applicants submit that the Examiner's obviousness rejection of claim 80 is overcome. The rejection to claim 81 is overcome due to its dependency on claim 80.

Claims 51-65 are rejected stand rejected under 35 U.S.C 103(a) as being unpatentable over Emmet, Jr. (US 5,007,620) in view of McWhirter (US 6,299,776), Eppstein (US 4,680,267) and Whellock (GB 2,225,256) as applied to claims 50, 67-69, 71-73, 80 and 81 above, and further in view of Steemson (WO 94/28184). For the reasons provided above, Applicants submit that the claims are in condition for allowance and request reconsideration and allowance of the claims.

Claims 70 and 74-79 stand rejected under 35 U.S.C. 103(a) as being unpatentable over Emmett, Jr. (US 5,007,620) in view of McWhirter (US 6,299,776), Eppstein (US 4,680,267) and Whellock (GB 2,225,256) as applied to claims 50, 67-69, 71-73, 80 and 81 above, and further in view of Brierley (US 5,332,559). For the reasons provided above, Applicants submit that the claims are in condition for allowance and request reconsideration and allowance of the claims.

In view of the foregoing, Applicant respectfully submits that the art rejections are overcome and that the application is now in condition for allowance. Accordingly, favorable reconsideration and allowance of the application is respectfully requested.

Respectfully submitted,

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